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Coverage Problem in Wireless Sensor Networks

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Abstract—**Sensor network are highly distributed networks of small light weighted wireless nodes deployed in large numbers to monitor the environment or system by the measurement of physical parameters such as temperature, pressure, light, vibration, humidity etc. Wireless sensor node consists of sensing, computing, actuation, communication and power component. An efficient method to extend sensor network lifetime by organizing the sensors into a maximal number of set cover thet are activated successively. Only the sensors from the current active set are responsible for monitoring all targets and for transmitting the collective data, while all other nodes are in low-energy sleep mode. By using different technique we increase the network lifetime.**

Keywords-Wireless Sensor Network; Coverage; Distributed Networks; Communication.

I. INTRODUCTION

Now a day's advances in miniaturization i.e. low power circuit design, simple, yet reasonably efficient wireless communication equipment and improved small scale energy supplies have combined with reduced manufacturing costs to make a new technological vision called wireless sensor network. [1]Sensor network are highly distributed networks of small light weighted wireless nodes deployed in large numbers to monitor the environment or system by the measurement of physical parameters such as temperature, pressure, light, vibration, humidity etc. wireless sensor node (or simply sensor node) consists of sensing, computing, actuation, communication and power component. These components are integrated on a single or multiple boards, and packaged in a few cubic inches. A WSN usually consists of tens to thousands of such nodes that communicate through wireless channels for information sharing and cooperative processing. A wireless sensor network consists of Sensing, computation, communication, actuation, power components (Fig. 1).

A wireless sensor network consists of three subsystems that are[5]:

1. Sensor subsystem: Sense the environment with the help of physical characteristics like temperature, Pressure, humidity and characteristics of object and their motion.

2. Processing sub system: Performs local commutation on sensed data.

3. Communication subsystem: Each sensor nodes can communicate with each other by exchanging the message.

Wireless sensor network is considered as a distributed database because usually user can retrieve information that we want from a WSN by giving queries and gathering result from

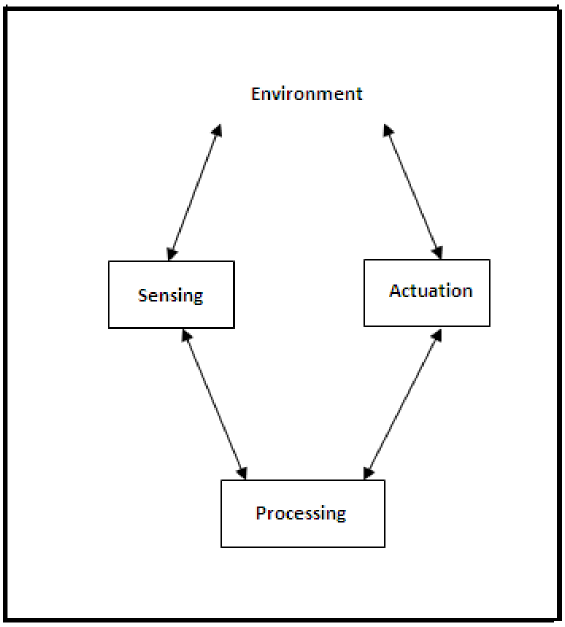

Figure 1. A Sensor Network System

sink nodes, where the sink node behaves as an interface between user and network.[6]

Challenges of WSN are ranging through network organization, topology discovery, communication scheduling, routing control, and signal processing.

A. *Energy Efficient Design[2][3][7]*

Once deployed, it is often infeasible or undesirable to recharge sensor nodes or replace their batteries. Thus, energy conservation becomes crucial for sustaining a sufficiently long network lifetime.

B. *Security:*

Since WSNs may operate in a hostile environment, security is crucial to ensure the integrity and confidentiality of sensitive information. To do so, the network needs to be well protected from intrusion and spoofing.

C. *Collaborative information processing and routing:*

The data-centric paradigm involves two fundamental operations in WSNs: information processing and information routing. Many research efforts are motivated by the fact that information processing and routing are mutually beneficial. While information processing helps reduce the data volume to be routed, information routing facilitates joint information compression (or data aggregation) by bringing together data from multiple sources.

D. Network discovery and organization:

Due to the large scale of WSNs, each sensor node behaves based on its local view of the entire network, including topology and resource distribution. Here, resources include battery energy and sensing, computation, and communication capabilities. To establish such a local view, techniques such as localization and time synchronization are often involved.

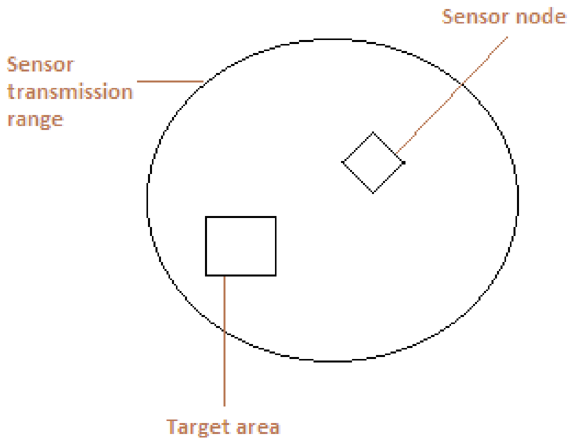

Figure 2: Problem Statement Definition 1

II. COVERAGE PROBLEM IN WIRELESS SENSOR NETWORK

Wireless sensor networks (WSNs) have attracted a great deal of research attention due to their wide-range of potential applications. A WSN provides a new class of computer systems and expands people's ability to remotely interact with the physical world. In a broad sense, WSNs will transform the way we manage our homes, factories, and environment. Applications of WSNs include battlefield surveillance, biological detection, home appliance, smart spaces, and inventory tracking. The purpose of deploying a WSN is to collect relevant data for processing/reporting. [4]There are two types of reporting: event-drive and on-demand. Consider a WSN with a sink (also called monitoring station) and a set of sensor nodes. In the event-driven reporting, the reporting process is triggered by one or more sensor nodes in the vicinity which detect an event and report it to the monitoring station. In the on-demand report, the reporting process is initiated from the monitoring station and sensor nodes send their data in response to an explicit request.[9] A forest fire monitoring system is event-driven, whereas an inventory control system is on-demand. A more flexible system can be a hybrid of even-driven and on-demand.

A. Sensor Coverage Problem

Coverage determines how well area is monitoring or tacked by a sensor node. Coverage depends upon the range and sensitivity of sensing nodes and location and density of sensing nodes in a given region. The worst case coverage define area of breach means where coverage is poorest. The best case coverage define area where coverage is best. The coverage concept is a measure of the quality of service (QoS) of the sensing function and is subject to a wide range of interpretations due to a large variety of sensors and applications. The goal is to have each location in the physical space of interest within the sensing range of at least one sensor.[4][8] Research in sensor network coverage has mainly followed four directions:

- Design communication protocol.
- Investigate coverage measures and develop analytical expressions of coverage properties based on these measures.
- Achieve maximum lifetime of sensor works.

B. Types of coverage problem

1) Area Coverage

The main objective of the sensor network is to cover (monitor) an area sensors to cover a given square-shaped area. The connected black nodes form the set of active sensors, as the result of a scheduling mechanism.[10]

2) Point Coverage

In the point coverage problem, the objective is to cover a set of points. A set of sensors randomly deployed to cover a set of points (small square nodes). The connected black nodes form the set of active sensors, the result of a scheduling mechanism.

3) Barrier Coverage

We consider the barrier coverage as the coverage with the goal of minimizing the probability of undetected penetration through the barrier (sensor network). A general barrier coverage problem where start and end points of the path are selected from bottom and top boundary lines of the area.

C. Sensor coverage problem:

If the area is k-covered means every point in area is covered by at least k-sensors. Where in general we take k=1. When k!=1, it provides stronger environmental monitoring, military application, fault tolerant purpose. Multiple sensors are required to detect an event i.e. triangulation based positioning protocol.

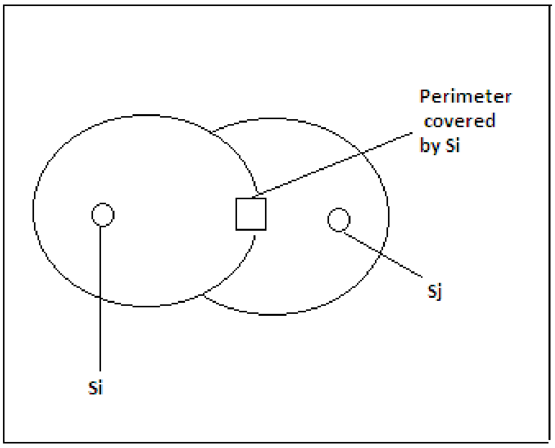

Figure 3: Problem statement Definition 2

D. Problem Statement

Definition 1: The location in A is said to be covered by Si if it is within Si's sensing range. The location in A is said to be j-covered if it is within at least j sensors' sensing ranges.

Definition 2: A point on the perimeter of Si is perimeter covered by Sj if this point is within the sensing range of Sj.

E. Constraint Coverage for Mobile Sensor Network

Constraints coverage is the problem of finding a deployment configuration which maximizes the collective

sensor coverage of the nodes while satisfying constraints. we consider constrained coverage for a network whose constituent nodes are all autonomous mobile robots. The constraint we consider is node degree - the number of neighbors of each node in the network. More precisely, we require each node to have a minimum degree K, where K is parameter of the deployment algorithm.

In our deployment algorithm, we construct virtual forces between nodes so that each node can attract or repel its neighbors. The forces are of two kinds. The first, Fcover, causes the nodes to repel each other to increase their coverage, and the second, Fdegree, constrains the degree of nodes by making them attract each other when they are on the verge of being disconnected. By using a combination of these forces each node maximizes its coverage while maintaining a degree of at least K. Each node. Begin with more than K neighbors and repels all of them using Fcover till it has only K left.

The resulting neighbors are called the node's critical neighbors and the connections between them and the node are called critical connections. The node now communicates to all its neighbors that its connection with them is critical and therefore should not be broken. It then continues to repel all its neighbors using F, but as the distance between the node and its critical neighbor increases. |FcOver| decreases and |Fdegree| increases. As a result, at some distance η Rc, where 0<η<1, the net force |Fcover + Fdegree| between the node and its neighbor is zero. At this distance, the node and its neighbor are in equilibrium with respect to each other. We call f the safety factor because the larger its value, the smaller the probability of critical neighbors losing connectivity. The forces are constructed as inverse square law profiles |Fcover| tends to infinity when the distance between nodes is zero so that collisions are avoided. Similarly |Fdegree| tends to infinity when the distance between the critical neighbors is R, so that loss of connectivity between them is prevented. Mathematically, the forces can be expressed. as follows. Consider a .network of nodes 1,2,3,. . .,n at positions xl, x2,. . . ,xn,-respectively. Let xij represents the Euclidean distance between nodes i and.j, i.e. xij= xi- xj :

F. *Application of coverage problem:*

Discovering insufficiently covered region: using larger k, the location of the event can be more precisely defined. Power saving in sensor network- if there are more number of sensor than necessary, than redundant notes can be turn off. Hot-spots: check whether the hot-spot area is k covered or not. When the number of sensors in any finite area is finite, then necessary and sufficient condition for the complete convex of a region to imply connectivity R 2r. Where R is the communication range and r is the sensing range of a sensor. The relationship between coverage and connectivity if target area is k-covered means it proves that if the region is k-covered than sensor network is k-connected.

III. CONCLUSION

We categorized and described recent coverage problems proposed in literature, their formulations, assumptions and proposed solution. Sensor coverage is an important element for QoS in applications with WSNs. Coverage is in general associated with energy-efficiency and network connectivity, two important properties of a WSN. To accommodate a large WSN with limited resources and a dynamic topology, coverage control algorithms and protocols perform best if they are distributed and localized. Various interesting formulations for sensor coverage have been proposed recently in literature. To meet the intended objective, these problems aim .at either deterministically placing sensors nodes, determining the sensor deployment density, or more generally, at designing mechanisms that efficiently organize or schedule the sensors after deployment.

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